STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

1410 North Hilton • Boise, ID 83706-1255• (208) 373-0502

January 22, 2002 **Final**

MEMORANDUM

TO: DEQ Wastewater Staff
Regional Administrators

FROM: David Mabe, State Water Quality Programs Administrator

SUBJECT: DEQ Wastewater Program Guidance -

Procedure for Evaluating Wastewater Treatment Lagoon Seepage Rates.

1.0 INTRODUCTION

This procedure has been revised from a previous procedure. The revisions include changing Division to Department, an expanded pan coefficient table, a recommended use of a temperature recorder, such as a "Hobotemp" weatherproof data logger, and a new definition of "mean air temperature".

2.0 PURPOSE

To establish a uniform standard procedure by which new and existing wastewater treatment lagoons can be evaluated to determine status of compliance with State seepage rate requirements.

3.0 DISCUSSION

Wastewater treatment lagoons constructed in the State of Idaho are required to meet a site-specific seepage rate as prescribed by the Department of Environmental Quality. In the past, measurements to determine compliance with the required seepage rate have been performed utilizing a wide variety of instruments and procedures. Adoption of a standard testing procedure will ensure consistent seepage measurement techniques.

4.0 GUIDANCE

1. The staff of the Department of Environmental Quality will provide seepage rate allowances to the entity proposing to construct wastewater treatment lagoons. The maximum allowance is 1/8" per day, which equals 3,395 gallons/day/acre.

2. Wastewater treatment lagoon plans and specifications submitted to the Department of Environmental Quality for review and approval should contain the following standard procedure.

3. Seepage test data shall be submitted for review and approval.

The following guidance material contains two main sections. The first section is a description of DEQ's standard seepage testing procedure. The last section is a suggested specification insert that may be used as guidance when developing a seepage testing procedure for a lagoon liner specification.

5.0 SEEPAGE TESTING PROCEDURES

Lagoons to be tested should be filled and maintained at design operational depth for at least two weeks prior to the beginning of the test period to allow for initial saturation (saturation period not required for synthetic lined lagoons). Measurements are to be taken at least every three days over a period of fifteen (15) days (0, 3, 6, 9, 12, 15) or longer until a consistent pattern is evident. One individual is to be responsible for all measurements and the measurements should be taken at the same hour of each test day.

Equipment[1]

1. Precipitation gauge
2. Temperature recorder, such as a Hobotemp weatherproof data logger
3. Class A evaporation pan and pan stilling well
4. Hook gauge with Vernier scale accurate to 0.001 ft.
5. Appropriate length of six (6) inch PVC pipe (Class 150 for stability) with suitable anchor support base for use as lagoon stilling well
6. Platform with support or boat for access to lagoon stilling well
7. Any necessary flow monitoring equipment

5.1 Evaporation/Precipitation

A precipitation gauge is to be set up and monitored daily. The evaporation pan should be located on a level area as close to the lagoon as possible. If necessary, shims should be used to level the pan. The obvious objective is to duplicate lagoon exposure as nearly as possible (sun, wind, rain, etc.). The pan stilling well should be anchored in the pan and not moved once the test period begins. Initial water level in the pan should be about two (2) inches below the lip. Air temperature is monitored to obtain the mean air temperature during the test period that in turn establishes the appropriate pan coefficient. Mean air temperature shall be defined as the mean of a minimum of 24 hourly temperature recordings in a twenty-four hour period. The measured pan evaporation is multiplied by the pan coefficient (Table 1) to obtain the lagoon evaporation.

5.2 Lagoon Seal

The lagoon stilling well should be installed as near to the center of the cell as possible. The stilling well must be installed at 90 degrees to the water surface for accurate measurements. Access to the stilling well is by boat or by installing a temporary platform. (DO NOT impinge upon the stilling well). Mark a spot on top of the stilling well to be used as a position indicator for the hook gage. All measurements must be taken with the hook gauge in the same position.

Each time a water surface is measured, hook gauge readings shall be repeated a minimum of seven (7) times and numerically averaged.

[1]Items 2, 3, and 4 are available through Forestry Suppliers Inc., P.O. Box 8397, Jackson, MS 39284-8397, (800) 647-5368 Internet www.forestry-suppliers.com; Fax (800) 543-4203

If possible, influent/effluent flows should be blocked to avoid unnecessary complications due to flow measurement errors.

Alternative lagoon stilling well locations will be reviewed/approved by the Department on a site-specific basis.

5.3 General Notes

1. A water source will be necessary for both the lagoon and the evaporation pan.

2. When constructing new lagoons, it may be more practical to install a permanent stilling well before filling the lagoon, rather than to use a temporary set-up.

3. A construction level will help in setting up the equipment properly.

4. On cloudy days, a flashlight may be helpful in seeing the hook gauge inside the stilling well.

5. Mean air temperature may be recorded using a HOBO temperature data logger.

5.4 Definitions

S_{r1} is the seepage rate in inches per day.

S_{r2} is the seepage rate in gallons per acre per day.

E_{s0} is the lagoon surface elevation, day 0 inches.

E_{sn} is the lagoon surface elevation, day n in inches.

ES is the lagoon surface elevation change in inches (E_{s0} - E_{sn}). Positive if the n day surface is lower than day 0; negative if the n day surface is higher than day 0.

I_L is the net lagoon evaporation which is calculated from the net corrected pan evaporation in inches (may be a positive or negative number).

Q is the net effluent flow in inches. May be positive (effluent > the influent flow) or negative (effluent < than influent flow). Value is zero if influent and effluent flows are blocked. (See equation on the next page).

n is time in days.

P is pan coefficient from Table 1.

E_{pan0} is the evaporation pan surface elevation, day 0 in inches.

$E_{pan\ n}$ is the evaporation pan surface elevation, day n in inches.

NOTE: All hook gauge readings must be subtracted from a datum elevation and multiplied by 12 to give water surface elevations in inches. The datum elevation may be assumed.

At a minimum, the following information should be recorded each time measurements are taken: date, time, air temperature, lagoon surface elevation (E_s), pan surface elevation (E_{pan}), precipitation, influent flow, and effluent flow. Then, the overall seepage rate for the testing period can be calculated using the following equations:

5.5 Seepage Rate Calculations

Seepage Equation 1: $S_{r1} = \frac{ES - I_L - Q}{n} = \frac{\text{inches}}{\text{day}}$

Seepage Equation 2:

$$S_{r2} = S_{r1} \frac{[\text{in}]\ [1\text{ ft.}]\ [43{,}560\text{ ft.}^2]\ [7.48\text{ gal.}]}{[\text{day}]\ [12\text{ in}]\ [1\text{ acre}]\ [\text{ft.}^3]} = \frac{\text{gallons}}{\text{acre/day}}$$

Where: $ES = E_{s0} - E_{sn}$ = inches

$I_L = P[\text{precipitation} + E_{pan0} - E_{pan\ n}] - \text{precipitation}$

$$Q = \frac{(\text{effluent flow - influent flow in gallons})\ (\text{ft.}^3)\ (12\text{ in})}{(\text{lagoon surface area ft.}^2)\ (7.48\text{ gals.})\ (\text{ft.})} = \text{inches}$$

5.6 Pan Evaporation (I_p)

$I_p = P[\text{precipitation} + E_{pan0} - E_{pan\ n}] - \text{precipitation}$

NOTE: Solving for I_p in the above equation assumes that the precipitation event was short duration. If a precipitation event during a seepage test is of extended duration, P should be multiplied by the factor:

$$\frac{\text{n hours - precipitation hours}}{\text{n hours}}$$

Definitions:

I_p = Net pan evaporation

P = pan coefficient from Table 1

n = time of seepage test

Table 1

Evaporation Pan Coefficient, P

Mean Air Temp F	Pan Coeff P
30	1.0000
31	0.9906
32	0.9812
33	0.9718
34	0.9624
35	0.9530
36	0.9438
37	0.9346
38	0.9254
39	0.9162
40	0.9070
41	0.8976
42	0.8882
43	0.8788
44	0.8694
45	0.8600
46	0.8508
47	0.8416
48	0.8324
49	0.8232
50	0.8140
51	0.8046
52	0.7952
53	0.7858
54	0.7764
55	0.7670
56	0.7578
57	0.7486
58	0.7394
59	0.7302

Mean Air Temp F	Pan Coeff P
60	0.7210
61	0.7116
62	0.7022
63	0.6928
64	0.6834
65	0.6740
66	0.6648
67	0.6556
68	0.6464
69	0.6372
70	0.6280
71	0.6186
72	0.6092
73	0.5998
74	0.5904
75	0.5810
76	0.5720
77	0.5630
78	0.5540
79	0.5450
80	0.5360
81	0.5264
82	0.5168
83	0.5072
84	0.4976
85	0.4880

6.0 SUGGESTED LAGOON SEEPAGE TESTING SPECIFICATION INSERT

Lagoon Liner - Liner integrity of each individual cell shall be evaluated in the following manner:

a. Evaporation - Shall be measured utilizing a Class A evaporation pan and pan stilling well arrangement. Pan measurements accurate to 0.012 inch (0.001 foot) shall be taken six (6) times over a period of fifteen (15) days (day 0, 3, 6, 9, 12, 15,). The pan coefficient for comparison is dependent on the mean air temperature (F) over the test period and shall be taken from Table 1.

b. Precipitation/Air Temperature - Precipitation shall be measured using a standard precipitation gauge accurate to the nearest 0.01 inch. Measurements shall be recorded following each precipitation event. Air temperature (F) shall be monitored and recorded, using a recording data logger such as a HOBO.

c. Lagoon - New or Existing Cells - Shall be filled and maintained at design operating level for at least two weeks prior to testing (not required for synthetic liners). During the test period, influent/effluent flows shall be blocked. A level, fixed stilling well located as near to the center of the lagoon as possible shall be used at the point for measurement. Measurements accurate to 0.012 inch (0.001 foot) shall be taken six (6) times over a period of fifteen (15) days (day 0, 3, 6, 9, 12, 15).

6.1 Definitions

S_{r1} is the seepage rate in inches per day.

S_{r2} is the seepage rate in gallons per acre per day.

E_{s0} is the lagoon surface elevation, day 0 inches.

E_{sn} is the lagoon surface elevation, day n in inches.

ES is the lagoon surface elevation change in inches (E_{s0} - E_{sn}). Positive if the n day surface is lower than day 0; negative if the n day surface is higher than day 0.

I_L is the net lagoon evaporation which is calculated from the net corrected pan evaporation in inches (may be a positive or negative number).

Q is the net effluent flow in inches. May be positive (effluent > the influent flow) or negative (effluent < than influent flow). Value is zero if influent and effluent flows are blocked. (See equation on the next page).

n is time in days.

P is pan coefficient from Table 1.

E_{pan0} is the evaporation pan surface elevation, day 0 in inches.

$E_{pan\ n}$ is the evaporation pan surface elevation, day n in inches.

NOTE: All hook gauge readings must be subtracted from a datum elevation and multiplied by 12 to give water surface elevations in inches. The datum elevation may be assumed.

At a minimum, the following information should be recorded each time measurements are taken: date, time, air temp., lagoon surface elevation (E_s), pan surface elevation (E_{pan}), precipitation, influent flow, and effluent flow. Air temperature shall be recorded minimally at hour intervals. Then, the overall seepage rate for the testing period can be calculated using the following equations:

6.2 Seepage Rate Calculations

Seepage Equation 1: $$S_{r1} = \frac{ES - I_L - Q}{n} = \frac{\text{inches}}{\text{day}}$$

Seepage Equation 2:

$$S_{r2} = S_{r1} \ \frac{[\text{in}]\ [1\text{ ft.}]\ [43{,}560\text{ ft.}^2]\ [7.48\text{ gal.}]}{[\text{day}]\ [12\text{ in}]\ [1\text{ acre}]\ [\text{ft.}^3]} = \frac{\text{gallons}}{\text{acre/day}}$$

Where: $ES = E_{s0} - E_{sn}$ = inches

$I_L = P[\text{precipitation} + E_{pan0} - E_{pan\ n}] - \text{precipitation}$

$$Q = \frac{(\text{effluent flow - influent flow in gallons})\ (\text{ft.}^3)\ (12\text{ in})}{(\text{lagoon surface area ft.}^2)\ (7.48\text{ gals.})\ (\text{ft.})} = \text{inches}$$

6.3 Pan Evaporation (I_p)

$I_p = P[\text{precipitation} + E_{pan0} - E_{pan\ n}] - \text{precipitation}$

NOTE: Solving for I_p in the above equation assumes that the precipitation event was short duration. If a precipitation event during a seepage test is of extended duration, P should be multiplied by the factor:

$$\frac{\text{n hours - precipitation hours}}{\text{n hours}}$$

Definitions:

I_p = Net pan evaporation

P = pan coefficient from Table 1

n = time of seepage test

Table 1

Evaporation Pan Coefficient, P

Mean Air Temp F	Pan Coeff P
30	1.0000
31	0.9906
32	0.9812
33	0.9718
34	0.9624
35	0.9530
36	0.9438
37	0.9346
38	0.9254
39	0.9162
40	0.9070
41	0.8976
42	0.8882
43	0.8788
44	0.8694
45	0.8600
46	0.8508
47	0.8416
48	0.8324
49	0.8232
50	0.8140
51	0.8046
52	0.7952
53	0.7858
54	0.7764
55	0.7670
56	0.7578
57	0.7486
58	0.7394
59	0.7302

Mean Air Temp F	Pan Coeff P
60	0.7210
61	0.7116
62	0.7022
63	0.6928
64	0.6834
65	0.6740
66	0.6648
67	0.6556
68	0.6464
69	0.6372
70	0.6280
71	0.6186
72	0.6092
73	0.5998
74	0.5904
75	0.5810
76	0.5720
77	0.5630
78	0.5540
79	0.5450
80	0.5360
81	0.5264
82	0.5168
83	0.5072
84	0.4976
85	0.4880

7.0 **CONCLUSION**

These guidelines should be followed to be protective of public health and the environment. This guidance document becomes effective today.